April 23

13:15 Meeting at the Olympia Terminal in Helsinki Harbour where the boat departs from. We will walk the boat together. Please do not be late.	
13:45	**Goëry Genty** *Welcome and useful information*
SESSION 1 - SPATIAL PROPAGATION EFFECTS	
14:00-14:20	**Rodislav Driben** *Bloch Oscillations of multidimensional nonlinear wave packets*
14:20-14:40	**Eugenio DelRe** *New optical phenomena in nano-disordered ferroelectrics*
14:40-15:00	**Alberto Amo** *Photonic Landau levels in polariton lattices*
15:00-15:20	**Andrea Marini** *Nonlinear optical effects by graphene and monolayer transition metal dichalcogenides*
15:20-15:40	**Marco Peccianti** *Terahertz Surface Nonlinear Dynamics*
15:40-16:00	**Claire Michel** *Superfluid motion and drag-force cancellation in a fluid of light*
16:00-16:30	Coffee break
SESSION 2 - NONLINEAR DYNAMICS IN OPTICAL FIBRES	
16:00-16:20	**Fabio Biancalana** *Modulation Instability with Angular momentum*
16:20-16:40	**François Copie** *Single-shot observations of modulation instability in optical fibres: full complex field acquisition and space-time evolution*
16:40-17:00	**Philippe Grelu** *Live dynamics of solitons, molecules and complexes in ultrafast lasers*
17:00	Boat leaves from Helsinki
17:00-17:20	**Arnaud Mussot** *New insights about Fermi Pasta Ulam recurrence in optical fibers*
17:20-17:40	**Abdelkrim Bendahmane** *Exploring the origin of the spectral sidebands observed in GRIN multimode fibers*
17:40-18:00	**Sergei Turitsyn** *Nonlinear techniques for analysis of nonlinear photonic systems*
18:00-18:30	Break
SESSION 3 - 3D NONLINEAR PROPAGATION	
18:30-18:50	**Sergei Chekalin** *Light bullets formation and decay in isotropic transparent dielectrics*
18:50-19:10	**Olga Kosareva** *Nonlinear transparency window for ultra-intense femtosecond laser pulses in the atmosphere*
19:10-19:30	**Marco Ornigotti** *Optical Vortices, Rotating Black Holes, and Resonant Enhancement of Hawking Radiation*
19:30-20:30	Discussion with Snacks and Drinks
21:00	Dinner

April 24

08:00-09:00	Breakfast
SESSION 4 - FREQUENCY CONVERSION IN INTEGRATED STRUCTURES	
09:00-09:20	**Benjamin Wetzel** *Smart supercontinuum sources: Customizing nonlinear interactions via adaptive on-chip pulse splitting*
09:20-09:40	**Roberto Morandotti** *Integrated Frequency Combs*
09:40-10:00	**Camille-Sophie Brès** *Pushing nonlinear performances of silicon nitride nanophotonic waveguides*
10:00-10:20	**Calum Maitland** *TBA*
10:20-10:40	**Eirini Tagkoudi** *Gas spectroscopy using low threshold mid-infrared radiation generated in Si_3N_4 waveguides*
10:40-16:00	Free time in Stockholm
17:00	Boat leaves from Stockholm
21:00	Dinner

April 25

08:00-09:00	Breakfast
10:30	Boat arrives in Helsinki

SPATIAL PROPAGATION EFFECTS

Eugenio DelRe

Title: New optical phenomena in nanodisordered ferroelectrics

We will review recent experiments in nanodisordered ferroelectric crystals that have allowed the observation of spatial rogue waves, optical turbulence, replica symmetry breaking, Fermi-Pasta-Ulam recurrences, along with giant broadband optical refraction and the beginning of what may be termed a white-light photonics.

Alberto Amo

Title: Photonic Landau levels in polariton lattices

Lattices of photonic resonators provide extraordinary emulators of solid-state physics phenomena. The possibility of controlling the onsite energy and hopping between sites allows one to design elaborate photonic bands with nonlinear properties. Here we use a honeycomb lattice of coupled polariton micropillars to implement tilted photonic Dirac cones. We unveil a novel kind of Dirac cone called type-III, which combines linear and flat band dispersions. To do so, we introduce a spatial asymmetry in the hopping of photons in the x and y directions of the lattice. When the hopping presents a spatial gradient, an artificial gauge field for photons is engineered, and photonic Landau levels are observed. These photonic Landau levels provide an extraordinary framework to study lasing and the effect of interactions in photonic flat bands.

Andrea Marini

Title: Nonlinear optical effects by graphene and monolayer transition metal dichalcogenides

We theoretically investigate harmonic generation and saturable absorption in graphene, discussing free-carrier generation and their ultrafast temporal dynamics in the atomically thin material. We further illustrate cavity-enhanced second-harmonic generation and parametric down-conversion by monolayer transition metal dichalcogenides, demonstrating that phase-matching free operation can be achieved in photonic micro-cavities embedding two-dimensional semiconductors as nonlinear optical media. Our results are promising for the development of integrated optical parametric oscillators and micro-sources of entangled photons.

Marco Peccianti

Title: Terahertz Surface Nonlinear Dynamics

An interesting problem in the optical-to-Terahertz nonlinear conversion in condensed matter is how to handle the exceptionally large relative bandwidth of the generated THz products and conciliate it with the challenges of conversion efficiency, momentum conservation and coherence. In this talk, we will present our most recent results concerning the exploitation of quasi-2D nonlinear systems for THz generation with their implication in the realisation of novel sources, methodologies towards wave manipulation as well as novel sub-wavelength imaging approaches based on nonlinear spatiotemporal THz wave reconstruction.

Rodislav Driben

Title: Bloch Oscillations of multidimensional nonlinear wave packets

The robust propagation of several types of nonlinear waves featuring Bloch oscillations (BOs) in multidimensional media will be presented. Hybrid nonlinear waves supporting BOs can be constructed of bright or dark solitons. The models considered have a discrete refractive index gradient in one dimension and are continuous in the orthogonal direction or directions. Such

systems can be realized both in photonic settings, where temporal dispersion of anomalous and normal types is able to support bright and dark solitons respectively as well as Bose–Einstein condensates (BECs), where bright or dark solitons appear due to the joint action of diffraction and self-focusing or self-defocusing nonlinearities. Furthermore, we show that a periodic variation of the refractive index gradient in the propagation direction allows us to realize the spatial analog of dynamical localization. In addition, we demonstrate light bullets of a peculiar dark-bright type that also feature robust BOs.

Claire Michel

Title: Superfluid motion and drag-force cancellation in a fluid of light

Quantum fluids of light merge many-body physics and nonlinear optics, revealing quantum hydrodynamic features of light when it propagates in nonlinear media. One of the most outstanding evidence of light behaving as an interacting fluid is its ability to carry itself as a superfluid. We recently reported a direct experimental detection of the transition to superfluidity in the flow of a fluid of light past an obstacle in a bulk nonlinear crystal. In this cavityless all-optical system, we extracted a direct optical analog of the drag force exerted by the fluid of light and measure the associated displacement of the obstacle. Both quantities drop to zero in the superfluid regime characterized by a suppression of long-range radiation from the obstacle. The experimental capability to shape both the flow and the potential landscape paves the way for simulation of quantum transport in complex systems.

NONLINEAR DYNAMICS IN OPTICAL FIBRES

Fabio Biancalana

Title: Modulation Instability with Angular momentum

We present an analysis of temporal modulation instability in a ring array of coupled optical fibers. Continuous-wave signals are shown to be unstable to perturbations carrying discrete angular momenta, both for normal and anomalous group velocity dispersion. We find the frequency spectrum of modulation instability is different for each perturbation angular momentum and depends strongly on the coupling strength between fibers in the ring. Twisting the ring array also allows the frequency spectra to be tuned through the induced tunneling Peierls phase.

François Copie

Titile: Single-shot observations of modulation instability in optical fibres: full complex field acquisition and space-time evolution

Light propagating in optical fibres might undergo a modulation instability which leads to the break-up of a continuous wave field. In this presentation, we review recent experiments where both the intensity and phase of the field are recorded at the output of a fibre thanks to an improved temporal imaging system, showing in details the formation of ultra-fast nonlinear structures. We also show how the spatio-temporal evolution of the intensity can be revealed using a recirculating fibre loop.

Philippe Grelu

Title: Live dynamics of solitons, molecules and complexes in ultrafast lasers

Soliton bound states in dissipative systems host a variety of internal dynamics, which can now be analyzed experimentally at the nanosecond time scale. Using the ultrafast fiber laser platform, I will present different types of oscillatory dynamics at play within several self-organized dissipative structures, soliton molecules and soliton molecular complexes.

Arnaud Mussot

Title: New insights about Fermi Pasta Ulam recurrence in optical fibers

We report recent results about FPU recurrence in optical fibers based on an original technic of distributed characterization in phase and intensity and thanks to an active compensation of optical losses. Consequently, the dynamics of more than 2 recurrences has been possible to be analyzed and compared to theoretical predictions.

Abdelkrim Bendahmane

Title: Exploring the origin of the spectral sidebands observed in GRIN multimode fibers

Nonlinear guided wave propagation in multimode fibers (MMFs) has received a renewed interest during the last few years. MMFs are indeed a perfect platform for the study of spatiotemporal dynamics of optical waves. In particular, several works have recently reported nonlinear beam reshaping and self-cleaning effects in MMFs with a parabolic refractive index profile known as graded-index or GRIN fibers. A Gaussian-shaped beam propagating in a GRIN fibers experiences periodic self-imaging. Under certain conditions, this effect can result in the development of a geometric parametric instability (GPI), which has been theoretically predicted by Longhi in 2003, but observed only a few years ago. However, the Longhi theory fails to explain the origin of all the spectral sidebands observed in experiments, especially at high pumping powers. Indeed, the additional spectral sidebands cannot be only related to the known GPI process, but rather originate from an interplay of different mechanisms. Using numerical simulations, theoretical calculations and experimental results, we succeeded in identifying these physical mechanisms. We also demonstrated that the impact of higher-order dispersion and Four-wave mixing are of fundamental importance.

Sergei K. Turitsyn

Title: Nonlinear techniques for analysis of nonlinear photonic systems

Understanding of the properties of nonlinear photonic systems is important both for the fundamental science and because of their relevance to numerous applications of light technology, from fibre-optic communication links to high power lasers. However, many measurement techniques and signal processing methods have been developed and optimised for linear systems. In this talk I will discuss our recent works on applications of the machine learning methods and nonlinear Fourier transform to analysis of dynamics of nonlinear photonic systems.

3D NONLINEAR PROPAGATION

Sergei Chekalin

Title: Light bullets formation and decay in isotropic transparent dielectrics

Olga Kosareva

Title: Nonlinear transparency window for ultra-intense femtosecond laser pulses in the atmosphere

We have found the optimum range of driver wavelengths for mid-infrared ultraintense femtosecond pulse undergoing filamentation in atmospheric air. This wavelength range between 3.1 and 3.5 microns forms the nonlinear transparency window identified through the diligent scan of the pulse central wavelength in the range 2.2-4.7micron with the best resolution of 5nm. Each of 123 wavelengths scanned corresponds to the solution of the full 3D+time pulse propagation and filamentation problem on 7-19 m path in air.

Marco Ornigotti

Title: Optical Vortices, Rotating Black Holes, and Resonant Enhancement of Hawking Radiation

In this work, we consider a Laguerre-Gaussian beam propagating in a defocusing Kerr nonlinear medium, and study the dynamics of fluctuations of the electromagnetic field on such a vortex background, leading to Hawking radiation, and super radiance. We discuss the strong connection between these two phenomena, and show, that the conditions for the onset of super radiance coincide with resonance enhancement of certain frequencies of Hawking radiation.

FREQUENCY CONVERSION IN INTEGRATED STRUCTURES

Benjamin Wetzel

Title: Smart supercontinuum sources: Customizing nonlinear interactions via adaptive on-chip pulse splitting

We report on the experimental control of coherent supercontinuum. Using an actively-controlled photonic chip to prepare patterns of femtosecond pulses via a genetic algorithm, we show efficient tailoring of nonlinear pulse propagation. Our experimental results, obtained using pulses with picoseconds separations injected into a highly-nonlinear fiber, display a wide tunability of the output supercontinuum spectral properties. In addition, numerical simulations demonstrate a more complete and efficient spectro-temporal control of the supercontinuum output using our integrated pulse-splitting technique. These results are expected to pave the way towards new approaches of smart imaging, sensing and metrology applications.

Roberto Morandotti

Title: Integrated Frequency Combs

The generation of optical quantum states on an integrated platform will enable low-cost and accessible advances for quantum technologies such as secure communications and quantum computation. We demonstrate that integrated quantum frequency combs (based on high-Q microring resonators made from a CMOS-compatible, high refractive-index glass platform) can enable, among others, the generation of pure heralded single photons, cross-polarized photon pairs, as well as bi- and multi-photon entangled qubit and quDit states over a broad frequency comb covering the S, C, L telecommunications band, constituting an important cornerstone for future practical implementations of photonic quantum information processing.

Camille-Sophie Brès

Title: Pushing nonlinear performances of silicon nitride nanophotonic waveguides

Silicon nitride is an excellent CMOS fabrication compatible alternative for integrated nonlinear optics. Not only does it offer excellent linear properties, but also a wide transparency window extending from the visible to the mid infrared, and large bandgap which can be engineered by changing the material composition. In this talk we will cover how nonlinear broadening is now reaching the middle infrared and how all-optical poling process can significantly enhance the typically weak second order nonlinearities.

Calum Maitland

TBA

Dmitry Skryabin

Title: Frequency comb solitons in ring microresonators with quadratic nonlinearity

We report theoretical results on generation of the soliton and quasi-soliton frequency combs in ring microresonators with quadratic and Kerr nonlinearities via the second-harmonic generation and

parametric down conversion processes. Bright comb solitons are found in either the all-normal or the mixed normal-anomalous dispersions suitable for practical experimental conditions.

Eirini Tagkoudi

Title : Gas spectroscopy using low threshold mid-infrared radiation generated in Si3N4 waveguides

The Mid-IR spectral region has attracted intense interest for spectroscopy and sensing applications. Direct generation of Mid-IR light through dispersive wave generation (DWG) in Si3N4 waveguides establishes a significant step towards compact frequency comb sources. However, limitations in terms of conversion efficiency beyond 3 μm implies input pump average power levels of hundreds of milliwatts to reach power requirements for fast spectroscopic application. In this talk we will show results on direct absorption spectroscopy of various gases in the Mid-IR, that only uses mW level of pump power.